REMARKS

Allowable Claims

Applicants gratefully acknowledge that claims 4, 11 and 12 were merely objected to as depending from a rejected base claim, but are otherwise allowable.

Rejections under 35 USC §102(b)

Claims 1-3 and 6-10 were rejected under 35 USC §102(b) as being anticipated by Atsushi (JP 2000-228302; applicant submitted).

The Office Action alleges as follows:

> Atsushi teaches a zinc resistor [0001 and fig. 1] comprising a pair of opposed zinc-oxide single crystal 11 and 12 each containing cobalt and manganese [0030] dissolved therein, and an oxide which containing of bismuth and boron 13 [0031 forming an oxide paste] between the zinc-oxide crystals, wherein the zinc oxide resistor exhibits zinc-oxide varistor characteristics [0001], and said bismuth-boron oxide interface layer is formed as a bismuth and boron oxide glass layer by the action of said boron contained therein.

(Office Action item 3).

However, claim 1 recites, as amended, "a pair of opposed zinc-oxide **single crystals** each containing cobalt and manganese dissolved therein in the form of a solid solution," "a bismuth-boron based oxide interface layer intervening between said zinc-oxide single crystals" and "wherein said zinc oxide resistor has non-ohmic properties or exhibits zinc-oxide varistor

characteristics, and said bismuth-boron based oxide interface layer includes a bismuth-and-boron-containing oxide glass phase"

In Atsushi, reference numerals 11 and 12 indicates "zinc oxide **ceramic**" but not "zinc-oxide **single crystal**." Thus, Atsushi does not teach or suggest, among other things, "a pair of opposed zinc-oxide **single crystals** each containing cobalt and manganese dissolved therein in the form of a solid solution."

The present invention provides a structure and production method for achieving zinc oxide varistor characteristics by a structure comprising a pair of opposed single crystals and a glass layer forming an oxide grain boundary layer. Thus, unlike a conventional varistor having zinc oxide ceramic, according to the present invention, the technique of joining the opposed single crystals makes it possible to improve controllability of a resistor so as to obtain a varistor having an intended function.

In order to achieve the above objects, a pair of zinc-oxide single crystals containing cobalt and manganese dissolved therein in the form of a solid solution are joined together to form a joined unit so as to provide a nonlinear current-voltage characteristic in a resistor having the joined zinc-oxide single crystals.

Moreover, instead of simply joining the zinc-oxide single crystals, an intervening layer containing bismuth oxide is formed in the junction interface between the zinc-oxide single crystals to enhance the nonlinear current-voltage characteristic of the zinc oxide varistor.

If the bismuth oxide layer intervening between the grain boundaries in the joined unit of the zinc-oxide single crystals is crystallized, the mechanical strength of the joined unit is likely to deteriorate. Thus, the grain boundary layer of the joined unit is formed of a bismuth-and-boron-containing oxide glass phase. In a process of forming this glass phase, the boron oxide added to the bismuth-containing layer residing in the junction interface can accelerate vitrification of the grain boundary layer by taking advantage of its feature of a low melting point.

The zinc-oxide varistor or resistor has a current-voltage characteristic with significantly high nonlinearity, and a resistance value to be reduced in response to a high-voltage noise. Therefore, the zinc-oxide resistor is used for protecting an electric/electronic circuit from an abnormal high voltage. The junction interface between the zinc-oxide single crystal/grain boundary layer/zinc-oxide single crystal distinctively provides significantly high nonlinearity at an operating voltage of about 3 V. Thus, in contrast to the conventional zinc-oxide varistor device having sintered body or polycrystalline body, the present invention makes it possible to set the number of interfaces of (zinc-oxide single crystal/grain boundary layer/zinc-oxide single crystal) at a desired value. Thus, the operating voltage for noise removal can be readily adjusted.

Thus, Atsushi does not teach or suggest "a pair of opposed zinc-oxide **single crystals** each containing cobalt and manganese dissolved therein in the form of a solid solution, and a bismuth-boron based oxide interface layer intervening between said zinc-oxide single crystals, wherein said zinc oxide resistor has non-ohmic properties or exhibits zinc-oxide varistor

characteristics, and said bismuth-boron based oxide interface layer includes a bismuth-and-boron-containing oxide glass phase."

For at least these reasons, claim 1 patentably distinguishes over Atsushi. Claims 2, 3 and 6-8, depending from claim 1, also patentably distinguish over Atsushi for at least the same reasons.

Similarly, claim 9 recites "disposing an oxide containing bismuth and boron, between a pair of opposed zinc-oxide **single crystals** to form a sandwich structure of (a zinc-oxide single crystal/a composition to be formed as a glass phase/a zinc-oxide single crystal)." Atsushi does not teach or suggest the recitation.

For at least these reasons, claim 9 patentably distinguishes over Atsushi. Claim 10, depending from claim 9, also patentably distinguish over Atsushi for at least the same reasons.

Rejections under 35 USC §103(a)

Claim 5 was rejected under 35 USC §103(a) as being unpatentable over Atsushi (JP 2000-228302) in view of Toyoshige (JP 2-219203; applicant submitted).

Toyoshige has been cited for allegedly disclosing a method of manufacturing of a varistor device wherein the resulting element can be controlled to have desired non-linear coefficient (alpha). Such disclosure, however, does not remedy the deficiencies of Atsushi discussed above.

For at least these reasons, claim 5 patentably distinguishes over Atsushi and Toyoshige.

In view of the aforementioned amendments and accompanying remarks, Applicants submit that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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